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Formal Encoding of Drama Ontology.

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Abstract. The goal of this research is to lay the foundations for a formal the
of drama, that abstracts from the procedural and interactive aspects involved
the generation of dramatic content. Based on the structural accounts provid
from traditional drama analysis, the theory proposed in this paper exploits
agent-based perspective on characters to provide a goal-based characterization
dramatic qualities.

1 Motivations

Since the advent of digital media, character-based, narrative forms of comm
have become commonplace in human-computer interaction, including user i
entertainment, and education [1,2,3,4,5]. The need for autonomous behavio
by these applications has led scholars to adopt the agent techniques develope
cial intelligence research to define and implement the virtual characters [6]. A
tions have evolved into multi-character, interactive systems, the need for a c
management of the plot execution has been realized by AI techniques for m
coordination and cooperation [7,8].

While the main effort of system developers has addressed the use of AI t
in the production of interactive storytelling applications, designers have re
the widely acknowledged corpus of drama studies - from Aristotle's investi
structuralist approaches - to characterize the dramatic qualities of virtual
However, there is still lack for computational theory that exploits the concep
of AI to characterize the principles of drama. The aim of this paper is to lay
dations of a formal theory that systematizes the basic aspects of drama in a
explicit model, with an immediate integration with agent-based theories. T
called *Drammar*, abstracts from the procedural aspects of drama generation,
tended as the starting point for specifying, implementing and evaluating pra
rytelling systems in a principled way.

Drammar is structured into two levels (see Figure 1). The *actional* lev
the intentional behaviour of the characters in a plot by enforcing a BDI pers
characters as intelligent, goal-directed agents: following Bratman's theory o
reasoning [9], belief-desire-intention (BDI) agents form goals to pursue the
and, given their beliefs about the world, devise plans to achieve them. Th
augmented with a representation of emotions as provided by the OCC model
directional level accounts for the realization of a direction through the plot, by
ing from the intentionality of the characters through the use of attributes that
effect of plot incidents onto the characters' (i.e. agents') mental and emotion

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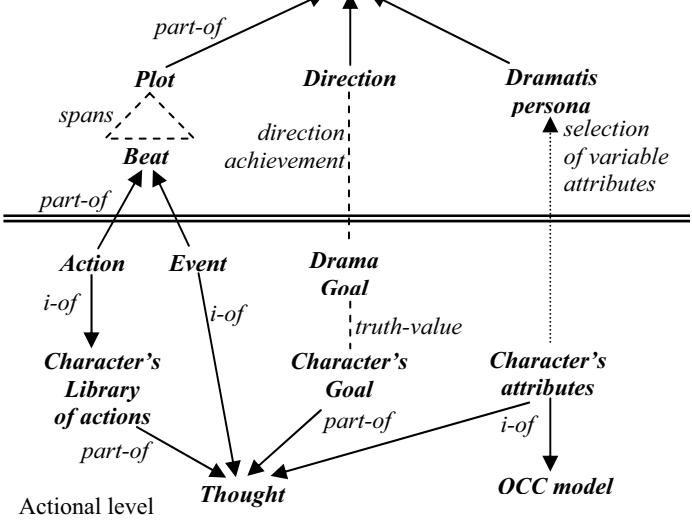

Fig. 1. Drammar ontology. The higher level represents the directional level, the lowes
resents the anchoring of directions in actions, i.e. the actional level.

In this paper we motivate and introduce the directional level of Dramm
apply it to a representative example of dramatic art, a fragment of Hitchc
North by Northwest. The paper first introduces the relevant issues, from the
on drama analysis, that are to be encoded in Drammar, and then presents
definition of Drammar. An example and the conclusions close the paper.

2 Drama Analysis

The goal of a drama is to make audience perceive what is intuitively called
by exhibiting the actions of some *characters* (in conflict); actions are orga
plot; the plot moves toward a *direction*. The notions of direction, character (a
dramatis persona) and plot, pervasive throughout the literature on drama an
the three components of the directional level of Drammar (see figure 1).

The drama direction derives from the notion of "unity of action", orig
pressed by Aristotle [11] and clearly stated by Stanislawsky and Styan [12,1
erational account of direction is the notion of *premise*, which takes a tripa
⟨*Character's value* at stake, *Conflict* (or direction of action), *Results* (or
[14,15]. The premise contains a movement caused by a conflict between on
ter and the environment and/or other characters. Such a movement concerns
or emotional value of the character. As we will illustrate, in Drammar, the *dra
tion* is a change function that transforms the initial state of a character into a
final state at the end of the drama [14,16]. Such states are defined through

The relationship between the value changes of the rational/emotional st
characters and the actual actions and events listed in a drama is stated th
notion of *drama goal*. The drama goal is the world state brought about by
that realizes the drama direction. In particular, the drama goal is operatively
as the achievement or the negation of the goal of a character, the drama *pr*
In the example above, the drama direction consists in the greedy character l
self and social esteem; an appropriate drama goal may be the state in which t
character is caught in the act of stealing the alms. The other characters, by
the achievement of their own goals, act as to oppose the protagonist (the *oppo*
to help him (the *extras*). The combination of the actions acted by the protag
the other characters, together with the environment events, achieve the drama
example, the goal of the greedy character to steal the alms without being caug
frustrated by the an opposite world state provided by the drama goal: as a con
the stealing plan of the greedy character will be opposed by other characters,
catch him red-handed.

The drama direction is defined as a rational/emotional state change ove
attributes that define the character, or *dramatis persona*. This set is divided
sub-sets, in order to combine the rational, Belief-Desire-Intention (BDI) persp
on agents with an emotional component. The rational attributes model the c
knowledge, subdivided into ontological, actional, social and normative, and h
tivation, or desires (the agent's long-term goals and preferences), that will tra
the intentions pursued by the agent at the actional level.[1] The emotional c
is structured along the lines provided by the Ortony-Clore-Collins (OCC)
model of emotions [10], widely employed in interactive drama systems [18
this model, emotions basically derive from the appraisal of events, action, a
in terms, respectively, of their desirability for the agent's goals, their praisew
according to the agent's moral standards, and their appealing according to t
dispositional attitudes. Attributes are valued positively or negatively; a value
an attribute can go from positive to negative or vice versa. In the example of t
character introduced above, the drama direction is accomplished by the cha
emotional attribute, *self-satisfaction*, which models an agent's approving (or d
ing) of the consequences of her/his own actions; this attribute turns from p
negative as a consequence of the failure of the character's goal of stealing the

Concerning the plot structure, it has been a well known convention, datin
Horace's Ars Poetica [20], to segment the list of actions that form a drama into
of units or sections, be it a "sequence of impressions" with a non-specified le
or a more clear-cut subdivision [21,22,23,24]. Segmentation has been form
semiotic studies in order to mark the discrete advancements of the narration
is important to notice that such units, despite terminological disparities, are o
nature, so that some authors define drama as a recursive or "fractal" structure

[1] In drama writing techniques, a similar account of characters as entities articulated i
cant features, classified along personality dimensions, is put forth by Seger [17].

the greedy character, the drama-unit characterized by the drama goal of st
money contains a smaller drama-unit characterized by the goal of finding
money is kept. Following McKee [24] and Elam [26], at the very end of the
structure there are the minimal units of the plot, called *beats*, pure actional un
by a action-reaction pair. The actual changes of the attribute values occur in
every beat is part of a least one drama-unit. Going back to the example of t
character, the failed stealing of the alms may be the last unit in a sequenc
which the character comes to know about the place where the alms have be
(first unit), then conceives the idea of stealing them (second unit), and event
into action (third unit). In the same way as the emotional change in the charac
satisfaction was modelled by the change of the *self-satisfaction* attribute, th
brought about in the character by the first two units can be modelled throug
attributes that model the rational connotation of the character: the fact that t
character comes to know about the hiding of the alms (a belief) is modell
change from negative to positive of the *knows_about_hiding* attribute, and th
he conceives the idea of stealing them (an intention) is modelled by the *want_*
attribute (accompanied by an emotion of *hope*), which takes a positive value.

The description so far implicitly assumes the we are working with line
where a unique list of beats is determined by a unique hierarchy of drama-
worth pointing out here that we do not claim that each drama has a unique inte
of its plot structure in terms of beats and drama-units, since each individ
audience may perceive a different structure, but that each interpretation co
to a unique plot structure. So, each interpretation proposed by the literary
about a specific drama maps to a unique plot structure. In non-linear drama, th
a unique list of beats, but a multiplicity of plots, licensed by a formal syste
formal grammar, a constraint-based system, etc.). Non-linear drama generaliz
of linear drama by resorting to a meta-system to generate the plot structure: th
lists of beats licensed by the meta-system are alternative realizations of the d
a linear structure is a special case that results from a non-ambiguous meta-s
an interactive version of the greedy character story, the user may decide w
character is to be caught red-hands or not: keeping the drama direction unc
the character succeeds in stealing the alms, he may for example contract a mo
because the alms were infected. Or else, the top level of the plot structure
change to a different one, for example, “ruin leads to redemption”, and the
once in jail, may redeem himself. Notice that the set of the characters’ variable
associated with the drama-units can be contradictory, since the multiplicit
can realize multiple drama directions and different characters’ sets. It is a
future research to determined what elements should be kept fixed (or unique
to achieve the coherence of the plot.

The units of the drama and their directions are combined in a drama-sp
gression that is related (via the protagonist’s fate) with the emotional enga
the audience. Dramatic actions in the plot trace a curve related to the fulfilm

in a beat included in some sub-unit of the unit itself. The temporal position of
is mapped onto a dramatic value based on the content of the unit, and the resu
cession of values forms a curve, the *dramatic arc*. The drama literature widely
edges an upside down U-shaped form of the dramatic arc: the first, the highe
last dramatic values have received specific names (inciting incident, expositi
ing conflict; climax, crisis, or turning point; conclusion or resolution [14,21,
If a drama is carefully designed, the dramatic arc reaches its peak towards t
the plot (some changes may occur later).

3 The Drammar Ontology

The ontology of drama presented here, called Drammar, consists of two level
tional level that encodes the specific traits of drama illustrated in the previo
and an *actional level* that connects such traits with an agent-based perspectiv
acters. At the directional level, a Drama-unit is a triple of Plot, Direction and
Personae. The actional level unfolds the rational and the emotional perspectiv
of the facts that occur in the Drama-unit, the goal of the Drama-unit, and the
of the characters. The facts can be either *Actions*, i.e. facts determined by
acters in pursuit of their aims (*Characters' Goals*) and belonging to the *C*
Library of actions, or incidental *Events*. The beliefs and long-term desires
the emotions of the characters are encoded in the *Characters' attributes*, wh
are instances of the rational knowledge (Thought in Aristotle's terms) or of th
types contained in the OCC model respectively.

Each element of the directional level is connected with some element at th
level through some specific relation. The actions and events represented in
at the actional level are listed in the Plot only as functional to the accompli
the Direction. The Direction, in turn, models the goals of the characters ac
a fulfilment/frustration dimension, through which the characters' dramatic qu
selection of their overall specification - are affected. The directional level of D
encoded in the notion of Drama-unit, which consists of a number of Dramatis
a Direction and a Plot (see Figure 1). Drama-units are organized in a hierarch
ture, which accounts for the segmentation of drama. We now present each co
then we provide the definition of the overall notion of drama.

The Dramatis persona is a set of ⟨attribute, value⟩ pairs, where the attr
binary-valued {+,–}. A drama-unit inverts the values of one or more attribute
characters. Not all of the attributes describing a character at the actional lev
affected by the changes carried out by the drama plot. For example, Othello ch
attitude toward Desdemona but does not resign from his military position; N
performing her stereotyped married life but does not stop loving her children

Definition: A dramatis persona $CHAR$ is a pair $\langle ATT, POLARITY \rangle$, wh
is a subset of $POOL$; $POLARITY$ is a set of pairs $\langle x, v_x \rangle$, where $x \in AT$

The Direction is a function $\mathcal{D}$ that specifies the value changes of the
attributes after the execution of the Plot element of a Drama-unit. So, the dom
direction function is a State (where a State is a set of Polarities of attributes
co-domain is another State. So, let a State be $\bigcup_i CHAR_i.POLARITY$:

$$\mathcal{D} : State_j \rightarrow State_f$$

where we enforce the *Minimal Direction* condition that at least one attribu
its polarity, i.e. there exists at least one attribute $a_i \in CHAR_i$ such that
assignment of a in the initial state $State_j$ is different from the value assignm
the final state $State_f$.

The drama-plot is the component that carries out the polarity inversions as
by the Direction function. It consists of a list of actions/events grouped in B
value changes required by the Direction function occur within one Beat. N
some Beat may not change any attribute value, but every change does occu
Beat. The three components above form a drama-unit.

Definition: A drama-unit is a triple $\langle Dramatis\_personae, Direction, Plot$

- $Dramatis\_personae$ is a finite set of Dramatis_persona $\{DP_1, DP_2, ...$
- $Direction$ is a function D defined as above;
- $Plot$ is a list of Beats $\langle B_1, B_2, \ldots, B_m \rangle$,

and the Minimal Direction condition holds.

A drama-unit represents by itself all the basic aspects of drama, as introdu
previous section. Drama-units are subdivided into smaller drama-units, unti
of elementary drama-units is reached. The resulting structure is a tree of dra
whose leaves are directly connected to beats, and whose root is the prope
drama, the highest-level unit that subsumes the entire sequence of beats. Fo
drama is the drama-unit that is not dominated by other drama-units.

The dramatic value of a drama-unit is provided by the number of value ch
occur within the unit or in some sub-unit. A drama-unit changes values eith
(that is, in a beat that it includes directly) or through a sub-unit (that is, in a bea
in a sub-unit). The horizontal (temporal) position of a drama-unit is the beat
last value change performed directly by the drama-unit occurs. Given a dr
the dramatic arc of that drama-unit is given by the line formed by connecti
dramatic values of the children units plus the unit itself.

4 An Example

In this section, we apply the formal system Drammar to the well-known H
North by Northwest [27], following the analysis reported in [23]. North by N
is about a middle-aged advertising executive, Roger Thornhill, who is mis

he will discover that Eve is an undercover CIA agent and together they will evil gang, on a thrilling sequence on the Mount Rushmore.

ID	Description	Drama Goal	Attribute	Value	Attribute-type
1	R. mistaken for Kaplan and kidnapped by Vandamm's gang	Kidnapped (Roger) True	Distress	+	EMOTION.well-being
2	R. gets aware of mismatch and tries get out of trouble	Involved (Roger) True	Individualism	-	BELIEF.norms
2.1	R. meets Vandamm	Agreement (Roger,Vandamm) False	Disappointment	+	EMOTION.prospect-based
2.1.1	Vandamm addresses R. as Kaplan	Mentioned (Vandamm,Kaplan) True	Distress	+	EMOTION.well-being
2.1.2	Vandamm threatens R. of death	Threatened (Vandamm.Roger) True	Anger	+	EMOTION.well-being/attribution
2.1.3	Vandamm's gang tries to kill R.; R. escapes	Killed (gang, Roger) False	Relief	+	EMOTION.prospect-based
2.2	Nobody believes R.; R. accused of shooting Townsend	Outcast (Roger) True	Isolation	+	BELIEF.world-state
2.2.1	R.'s report not believed by anybody	Discredited (Roger) True	Anger	+	EMOTION.well-being/attribution
2.2.2	R. leaves his mother	Left (Roger.Mother) True	Submission	-	BELIEF.social
2.2.3	R. is believed to have killed Townsend	Falsely_accused (Roger.assassination) True	Disappointment	+	EMOTION.prospect-based
2.3	R. escapes police, meets Eve, seduction, fake appointment	Seduced (Eve.Roger) True	Love	+	EMOTION.attraction
2.3.1	R. runs away by train	Caught (Roger.Train) True	Relief	+	EMOTION.prospect-based
2.3.2	E. hides R. from police in the cabin	Hidden (Roger) True	Gratitude	+	EMOTION.well-being-attribution
2.3.3	R. and E. sleep together	Had_sex (Roger.Eve) True	Satisfaction	+	EMOTION.prospect-based
2.3.4	E. fixes the fake appointment with Kaplan	Deceived (Eve,Roger)True	Hope	+	EMOTION.prospect-based
2.3.5	Airplane tries to kill R.	Meeting (Roger,Kaplan) False	Disappointment	+	EMOTION.prospect-based
2.4	R. calls E.'s bluff and Professor explains	Explain (Professor,Roger) True	Anger	+	EMOTION.well-being-attribution
2.4.1	R. discloses E.	Deceive (Eve,Roger) False	Reproach	+	EMOTION.attribution
2.4.2	R. finds about Vandamm and E.	Unmasked (Roger.Vandamm) True	Anger	+	EMOTION.well-being-attribution
2.4.3	R. arrested and meets Prof.	Meeting (Professor,Roger) True	Truth	+	BELIEF.world-state
2.4.4	E.'s identity revealed	Revealed (Eve's identity,Roger) True	Pity	+	EMOTION.fortune-of-others
3	R. takes revenge	Married (Roger,Eve) True	Family	+	BELIEF.norms
3.1	E. pretends shooting R. at M. Rushmore	Collaboration (Roger,Eve) True	Relationship	+	BELIEF.social
3.1.1	E. fake-shoots R.	Deceived (Roger,Vandamm) True	Satisfaction	+	EMOTION.prospect-based
3.1.2	E. to leave with Vandamm	Coupled (Roger,Eve) True	Love	+	EMOTION.attraction
3.2	Chase and fight at M. Rushmore	Saved (Roger.Eve) True	Gratification	+	EMOTION.well-being/attribution
3.2.1	R. escapes from hospital	Rebellion (Roger,Professor) True	Independence	+	BELIEF.normative
3.2.2	Leonard discloses Eve's secret	Informs (Leonard,Vandamm, Eve's trick) True	Fear	+	EMOTION.prospect-based
3.2.3	R. kills Leonard on M. Rushmore	Killed (Roger,Leonard) True	Relief	+	EMOTION.prospect-based

Fig. 2. Analysis of North by Northwest

standard filmic terminology. For example, Act 1 - being introductory - is not s
into smaller units, while Act 2 and 3 consist of 4 and 2 sequences respectivel

The second column, Description, contains an informal description of th
unit. The third column, Drama goal, contains the drama goal through whi
rection of the Drama-unit is accomplished. The state to be accomplished is
as the state in which a certain predicate is true or false. For example, Act
leads to a state in which the moral standards of the protagonist, Roger Tho
been affected, so as to make him more inclined to help the others (the prec
volved(Roger)" becomes true). This drama goal will be in turn accomplishe
the drama goals of the sub-units that compose it: the accomplishment of thi
mation will be carried out by Roger's need to take himself out of a big troub
oped in Sequences 2.1 and 2.2), together with the seduction operated on hi
(Sequence 2.3) and the awareness of a conflict between the intelligence serv
country and a group of evil spies (Sequence 2.4).

The last three columns, Attribute, Value and Attribute-type, describe the
of each Drama-unit. In Drammar, the Direction consists in the change of th
one or more attributes. For example, in Act 1, Roger falls into distress as a co
of being kidnapped by Vandamm's gang, setting the emotional attribute "d
a positive value; in Act 2, Roger's "individualism", initially set to "–", is se
Although the attributes of the characters affected by changes belong to both
nal and emotional category (individualism and distress are representative o
as reported in the Attribute-type column), most attributes belong to the emoti
especially in lower-level drama-units. The subtype to which each attribute
expressed by the dot notation: for example, the "BELIEF.norms" expressio
to "individualism" means that this attribute belongs to the normative com
the character's rational connotation. When emotional attributes occur, their
tion refers to the OCC cognitive model of emotional appraisal. For space re
relation between the emotion activation and the character's appraisal is not
represented in this table; for each attribute, we only report to which class of
it belongs according to OCC classification of emotion types. For example, i
of Sequence 4 of Act 2 (ID 2.4.1), Roger realizes that Eve, after seducing h
ing against him: we classify his mental state as dominated by reproach, as
of the moral evaluation of the behavior of Eve, construed as an agent. How
important to notice that the same situation could be as well construed as an u
event by Roger, and thus be a source of distress. Finally, the undesirable effec
blameworthy behavior for Roger may determine Roger's anger.

The last column (Drama value) reports the dramatic value of each drama
space reasons, we do not report a diagram of the dramatic arc, since its U-sh
can be appreciated only by considering the temporal position of the beats
attribute changes occur.

analysis. Although a number of systems have been developed for the gen
dramatic content, spanning from explicitly drama-oriented systems [28,1] to
systems [29,8,30], a formal characterization of the output generated by thes
is still lacking. Based on a broad analysis of traditional literature on drama
terms, Drammar accounts for the definition of drama on two levels: a directi
which specifies the qualifying features of drama in a functional way, and th
level, which models the actions acted by the characters in the plot in an ag
perspective.

The Drammar system provides a language for describing drama as an off-l
independent of specific applications. It relates the realization of a drama di
the achievement of a goal at the actional level, but allows the same direc
realized by different goals, and the same goal to be brought about by differe
of action and events. Interactive drama takes advantage of the non-determin
accomplishment of the direction, by letting the user navigate the space of a
plots. From the off-line, ontological point of view, it does not matter if the ch
determine the final plot are accomplished by the author before the user's frui
a collaborative process between the author and the user through a procedural

The description of drama ontology provided in this paper is only a first st
a comprehensive formal system, that includes a decision procedure for ana
generating drama. Several instruments have been proposed to this aim, ran
story-oriented approaches (rooted in story grammars [31] and scripts [32]) to
based systems, in which the story emerges as a result of the interplay of the b
multiple agents. In this paper, we have specified the requirements of drama in
tive of system design and evaluation, and leave to future research the task of i
the instruments by which the formal theory may be incorporated into practica

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